KANSAS MASTER NATURALIST PROGRAM

ICHTHYOLOGY

CHAPTER GOALS:

- Demonstrate an appreciation for fishes and an interest in ichthyology
- Discuss the diversity of fishes in Kansas and demonstrate familiarity with the different groups of fishes
- Understand the relationships among various groups of fishes
- Demonstrate knowledge about the general characteristics of the major groups of fishes
- Discuss basic principles of fish behavior, physiology and ecology and relate these principles to environmental adaptations

Bluegill

Channel Catfish

Walleye

Paddlefish

A. Why Study Fish?

Fish = term used for one organism or multiple organisms of the same species
Fishes = termed used when referring to many different species

Although Kansas is not famous for its fishes, the state has a fairly rich fauna of 135 species, of which 116 are native and 19 are introduced. This is a larger number of native kinds than occur naturally in any state farther west or directly north of Kansas.

Organisms that we classify as fishes are more numerous in number of species, have a greater variety of body shapes, occupy a greater number of habitats, feed on a greater range of prey with a greater variety of feeding mechanisms, and have a larger number of modes of reproduction than the other groups of vertebrates (amphibians, reptiles, birds, and mammals). In fact, some of the things that fishes do in their life pursuits boggle our minds. In addition, fishes have now been dated back to the dawn of life in the fossil record, and fishes gave rise to the other vertebrate groups, including human kind, thus the study of fishes may reveal much about the other groups of vertebrates. Recently found fossils of jawless fishes from China date to the Early Cambrian (535 million years ago) when most of the phyla of organisms first appear in the fossil record. These early fishes gave rise to the tetrapods (amphibians, reptiles, birds, and mammals) in the Devonian (about 390 million years ago).

Historically, why were fishes studied and why does it remain important?

From the mid-eighteenth to the early twentieth century natural history was a major scientific field that was investigated to further our knowledge (knowledge for knowledge's sake). However, some of the major expeditions were led by the military or by other representatives of the Federal Government and had geopolitical or economic goals. Examples of government-sponsored expeditions include the Lewis and Clark Expedition to the West Coast (1803-1806) and the Long Expedition to the Rocky Mountains (1819-18-20, 1823). By the late 19th and early 20th century, the government was conducting fishery surveys both in fresh and marine waters. These surveys were conducted to assess fishery resources. Also at about this time, government fishery labs and hatcheries were raising fishes to stock streams and lakes across the United States. Fishery surveys and stocking programs continue to the present day to assess and to increase our fishery resources.

B. Diversity of Fishes

Fishes also defy identification. They are defined mostly by what they are not rather than what they are. They are vertebrates that, for the most part, live in the water and lack limbs (forelimbs and hind-limbs). In other words, fishes are vertebrates other than tetrapods. As is often the case, when a group of animals cannot be defined, it generally means that they do not form a natural group, and such is the case with fishes. A natural group of animals is derived from a single ancestor. The other vertebrates,

amphibians, reptiles, birds and mammals, are clearly definable, constitute natural groups, and each is thought to have a common ancestor.

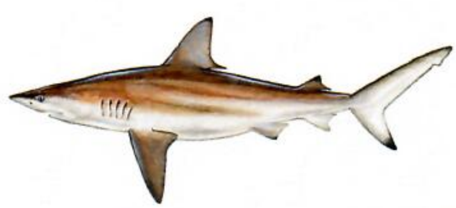
Fishes in fact comprise four natural groups, the hagfish, lampreys, cartilaginous fish, and the ray-finned fish. Hagfish are the most primitive vertebrates and are defined by lacking mandibular jaws, paired fins, clearly defined vertebrae, and functional eyes. They are entirely marine and live largely buried in soft sediments where they feed on soft-bodied invertebrates and carrion. There are about 43 species worldwide. Lampreys also lack mandibular jaws and paired fins, but they have true vertebrae and eyes. Their mouth consists of an oval sucking disc that enables them to attach to other fishes and feed on their flesh. They occur in both fresh and marine waters, but all species reproduce in freshwater. There are 41 living species and one species lives in the freshwaters of Kansas. Cartilaginous fish have mandibular jaws and true vertebrae and are distinguished from the ray-finned fish in possessing cartilaginous skeletons, teeth-like scales with an enamel-like covering, and horny fin rays (ceretotrichia) that are unsegmented and unpaired. They are commonly known as the chimaeroids, sharks, skates and rays, and for the most part are found only in marine waters. There are about 1000 living species, with none in Kansas. Ray-finned fish possess mandibular jaws, bony skeletons, thin scales lacking an enamel-like covering, and segmented and paired fin rays (lepidotrichia). Ray-finned fish occur in all habitats where fishes occur. There are over 24,000 species.

Fishes now number over 25,000 species, compared with 23,170 species of other vertebrates, and an additional 100 to 200 fish species are described every year with no end in sight. On the other hand, few amphibians and reptiles are described each year, and almost no birds or mammals will be described in the future. It is estimated that when all aquatic areas of the Earth are thoroughly surveyed that there will be about 40,000 species of fishes, almost twice the number of the other vertebrates combined. The bulk of the new species will come from the tropical waters of the western Pacific and Indian Oceans, and the fresh waters of tropical South America, Africa, and Southeast Asia.

Hagfish

Lamprey

Ray-finned Fish (Bluegill)



Cartilaginous Fish (Blacktip Shark)

C. SHAPES OF FISHES

Although most people have a mental image of a "fish" as a spindle shaped animal that in many cases resembles a minnow or salmon, with a terminal mouth, single dorsal fin centered at about mid length, a forked-shaped tail or caudal fin, pelvic fins located on the belly and an anal fin slightly posterior to the dorsal fin, fishes exhibit a vast repertoire of shapes. The typical fish shape described above fits those pelagic fishes that actively swim in the water column. There are only a few shapes that are acceptable for an active life in the water column because of the negative effects of density and viscosity of water on locomotion.

Fishes must expend considerable energy to overcome the thickness and stickiness of water. The shape described above minimizes the impedance of water to locomotion. Thus fishes that actively move through water tend to be similar in shape. The most active and fastest swimmers are the most constrained in shape because resistance of water increases with speed. Thus fishes that pursue such a life have to be of similar shape. These fishes are shaped like mackerel, tuna, and white sharks. Note that porpoises, dolphins, and whales resemble these fishes because they have the same constraints. Fishes that are suspended in water but swim slowly are less constrained and assume a greater variety of shapes.

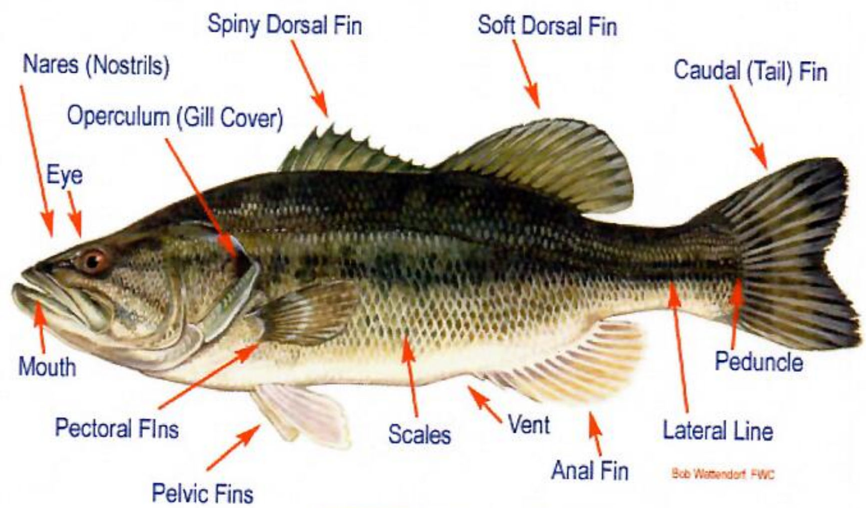
Shapes range from long and eel-like fishes to short and globular or box shaped. Rather than being optimized for speed these fishes are optimized for energy conservation. They are, however, constrained in regards to their density. They must be the same density as the water in which they swim in order to stay afloat. If they are heavier than water they will have to expend energy to remain afloat. Density is reduced by storing low-density oils in the flesh, gastro-intestinal tract, or bones, or by possessing a swim bladder. Swim bladders are outgrowths of the intestinal tract and are found only in ray-finned fish.

Fishes that live around coral reefs have another kind of constraint related to intricacies of the reef habitat. These fishes are specialized for maneuverability. For this reason they tend to be short, compressed and deep bodied, with the paired fins anteriorly arranged one above the other. The paired fins function as rudders and braking devices, and are most efficient when placed anteriorly one above the other. As with the slow moving pelagic fishes, they need to be neutrally buoyant to remain suspended in the water column with minimum effort and thus they would likely possess a swim bladder.

Fishes that spend a majority of their life on the bottom (benthic fishes) are less constrained in their shapes. For a number of reasons, it is often advantageous to blend in with the background. Camouflage can protect benthic fishes from predators and/or allow them to ambush their prey. Benthic fishes tend to be elongated and depressed.

In summary, the shape of fishes is related to a number of factors in their particular habitat and the ultimate shape is a compromise among a host of factors concerned with locomotion, feeding, and staying alive. With a basic idea of the constraints of different environments, it is possible to examine the shape of a fish and to predict where it lives.

The shape is also determined by the genetic potential of the fish species. If the fish species does not have the genetic blueprint for a particular shape, the shape will not happen. For instance, ray-finned fishes are for the most part not depressed or flattened but there is apparently a need for the flattened shape in benthic habitats. To compensate, one group of fishes have become compressed and then lie on their side to approximate a depressed shape. These fishes are the flatfish. Flatfish include flounder, halibut, and sole. They start out life very much compressed but during development one of their eyes migrates to the other side of the head and they assume a benthic existence by laying on either their right of left side. These fishes are truly unique among the vertebrates in being asymmetrical.



EXTERNAL ANATOMY

D. How have fishes adapted to their environment?

1. Feeding

The other groups of vertebrates display wide variety of modes of feeding but none rival the fishes. Fishes range from carnivores, omnivores, herbivores, to parasites, and the variety of feeding modes within each of these categories is truly amazing. There are straight-forward carnivores that swim down their prey. Others, however, are lie and wait predators that lurk in the shadows or weed beds or lie buried in the sand and ambush unsuspecting prey. Many of the ambush predators are aided with great suctorial mouths to engulf prey or electric organs to stun their prey. Another group of fishes is endowed with a dorsal fin spine modified into a fishing pole and a lure to entice their prey to within their range. The relative size of prey varies tremendously. Some of the largest fishes such as the manta rays, basking sharks, and whale sharks feed on minute zooplankton that are filtered out of the water. Deep-sea viperfish are able to disarticulate their jaws (like snakes) and have greatly distensible stomachs and engulf fishes larger than themselves. Many pelagic sharks and piranhas have cutting teeth and are able to take bites out of their prey. Pipefish and seahorses have syringe like mouths and suck individual zooplankton out of the water column. The archerfish dislodges terrestrial insects from plants above the surface by spitting drops of water.

A large number of fishes, including some of the most derived, are herbivorous. Most consume algae because much of it is rather easy to break up and digest compared to vascular plants. Few if any fishes are able to digest cellulose or have resident bacteria in their guts that can break down cellulose. Most herbivores simply graze and browse algae off substrates. Some of these herbivores (parrotfish, filefish, and triggerfish) have beak-like teeth for cutting the algae, others (loaches, armored catfish, and some cichlids) have lips and jaw teeth that resemble scrub-brushes and scour rocks and other hard substrates of algae. Damselfish are special in that they can be considered farmers that cultivate stands of algae growing on coral heads. These fishes are territorial and stake out manageable substrates on coral heads and keep all other herbivores out. With little grazing pressure, algae grow on the coral substrates and the damselfishes weed out types of algae that are uneatable.

Parasitic fishes are not that uncommon but they have a wide variety of means of obtaining nutrients from their hosts. A majority of the lampreys attach themselves to other fishes by means of their suctorial discs, rasp holes in the sides of their host, and live on the body fluids. The other jawless fishes, hagfish, use their rasping jaws to burrow into dead and dying fishes and consume their hosts from the inside. A deep-sea eel feeds in a similar manner but unlike the hagfish has mandibular jaws. There are a number of fishes in tropical freshwaters that live on the scales removed from their hosts.

2. REPRODUCTION

All life on earth succeeds because parents are successful in replacing themselves in the succeeding generation. In other words, on an average, each parent replaces itself with a reproductive adult during its lifetime. Each parent, on an average, produces a single reproductive offspring. Fishes have evolved a wealth of modes of reproduction and rival the rest of the vertebrates in their variety of modes of reproduction. The vast majority of fishes are single sexed (either males or females) and broadcast their sperm or buoyant eggs into the water. The sperm fertilizes the eggs and the fertilized eggs float off and are on their own. The parents end their parental involvement with the spawning act. This type of reproduction is very chancy in that the fertilized eggs have a very small probability of survival. The floating fertilized eggs are consumed by a host of predators. Thus fish species that practice broadcast spawning produce millions of eggs and of these millions approximately two survive to reproduce.

Other species invest less energy in producing gametes and more energy into insuring that their fertilized eggs have a reasonable chance of survival. A number of fishes produce large sticky eggs that are fertilized and deposited in places relatively free of predators. Eggs may be deposited on aquatic plants, shells, or buried in the bottom. A subset of fishes that deposit fertilized eggs in safe areas will remain with the eggs until the eggs hatch and thus invest additional energy in their offspring. Some such as the Siamese fighting fish build bubble nests and defend the nest and newly hatched young until they can defend themselves. The freshwater angelfish deposit fertilized eggs on leaves of aquatic vegetation, fan the eggs to insure they get enough oxygen and defend the newly hatched young from predation. The ultimate in egg depositors are those fishes that carry their young either in their mouths or on their bodies. A number of the cichlid fishes scoop up the fertilized eggs after spawning and mouth brood them until the young are fairly accomplished swimmers. Male sea horses and pipefish brood their young in belly pouches. A number of different groups of fishes have gone the route of mammals in brooding their young internally. This is the case in the majority of the sharks and rays,

and in a number of the ray-finned fishes. Generally fishes that practice internal brooding produce a very large egg that has a large supply of yolk to nourish the young. However, some fishes with internal development supply nourishment to the young through uterine milk, unfertilized eggs or through a placental attachment. In one unique case in a species of shark the first embryo to descend into the uterus consumes all subsequent embryos.

In addition to the great diversity of reproductive modes fishes are diverse in their sexual orientation. Most fishes are either males or females and remain so throughout their lives. However, some, such as the sea basses, start out life and first function as females and later change to and function as males. Other fishes such as parrotfish have primary males and females but some of the females change into secondary males that are very different in coloration than the primary males. There are a few fishes that are bisexual and actually fertilize themselves.

3. Function in Ecosystems

In their habitat, fishes are most likely at the top of their food chain. They dominate their habitat by consumption, which sometimes includes each other. In most habitats, fishes are more diverse in number of species than all of the other multi-cellular animals. In other words fishes as a group appear to dominate many to most aquatic habitats. Also they have a decided effect on the other multi-cellular organisms through predation.

A number of freshwater and brackish water fishes consume larvae such as mosquitoes. Mosquitoes are often vectors for diseases. Thus the fishes that consume mosquitoes are often important in the control of malaria and other mosquito–transported diseases.

E. Fishes of Kansas

Species in **red** = extirpated from the wild
* = not native to Kansas

Order of Lampreys (Petromyzontiformes)

Family Petromyzontidae	Chestnut Lamprey - Ichthyomyzon castaneus

Order of Sturgeons and Paddlefish (Acipenseriformes)

Family Acipenseridae	Lake Sturgeon - Acipenser fulvescens
	Pallid Sturgeon - Scaphirhynchus albus
	Shovelnose Sturgeon - Scaphirhynchus platorynchus
Family Polyodontidae	Paddlefish - Polyodon spathula

Order of Gars (Lepisosteiformes)

Family Lepisosteidae	Spotted Gar - Lepisosteus oculatus
	Longnose Gar - Lepisosteus osseus
	Shortnose Gar - Lepisosteus platostomus

Order of Bowfins (Amiiformes)

Family Amiidae — Bowfin - *Amia calva*

Order of Bony-tongued fishes (Hiodontiformes)

Family Hiodontidae — Goldeye - *Hiodon alosoides*

Mooneye - *Hiodon tergisus*

Order of Eels (Anguilliformes)

Family Anguillidae — American Eel - *Anguilla rostrata*

Order of Herrings (Clupeiformes)

Family Clupeidae — Skipjack Herring - *Alosa chrysochloris*

Gizzard Shad - *Dorosoma cepedianum*

Threadfin Shad - *Dorosoma petenense**

Order of Carp-like fishes (Cypriniformes)

Family Cyprinidae — Central Stoneroller - *Campostoma anomalum*

Goldfish - *Carassius auratus*

Grass Carp - *Ctenopharyngodon idella**

Bluntface Shiner - *Cyprinella camura*

Red Shiner - *Cyprinella lutrensis*

Spotfin Shiner - *Cyprinella spiloptera*

Common Carp - *Cyprinus carpio**

Gravel Chub - *Erimystax x-punctatus*

Western Silvery Minnow - *Hybognathus argyritis*

Brassy Minnow - *Hybognathus hankinsoni*

Plains Minnow - *Hybognathus placitus*

Bighead Carp - *Hypophthalmichthys nobilis**

Cardinal Shiner - *Luxilis cardinalis*

Striped Shiner - *Luxilis chrysocephalus*

Common Shiner - *Luxilus cornutus*

Redfin Shiner - *Lythrurus umbratilis*

Sturgeon Chub - *Macrhybopsis gelida*

Shoal Chub - *Macrhybopsis hyostoma*

Sicklefin Chub - *Macrhybopsis meeki*

Silver Chub - *Macrhybopsis storeriana*

Peppered Chub - *Macrhybopsis tetranema*

Redspot Chub - *Nocomis asper*

Hornyhead Chub - *Nocomis biguttatus*

Golden Shiner - *Notemigonus crysoleucas*

Emerald Shiner - *Notropis atherinoides*

Red River Shiner - *Notropis bairdi*

River Shiner - *Notropis blennius*

Bigeye Shiner - *Notropis boops*

Ghost Shiner - *Notropis buchanani*

Bigmouth Shiner - Hybopsis dorsalis

Arkansas River Shiner - *Notropis girardi*
Blacknose Shiner - *Notropis heterolepis*
Ozark Minnow - *Notropis nubilus*
Carmine Shiner - *Notropis percobromus*
Silverband Shiner - *Notropis shumardi*
Sand Shiner - *Notropis stramineus*
Topeka Shiner - *Notropis topeka*
Mimic Shiner - *Notropis volucellus*
Pugnose Minnow - *Opsopoeodus emiliae*
Suckermouth Minnow - *Phenacobius mirabilis*
Southern Redbelly Dace - *Phoxinus erythrogaster*
Bluntnose Minnow - *Pimephales notatus*
Fathead Minnow - *Pimephales promelas*
Slim Minnow - *Pimephales tenellus*
Bullhead Minnow - *Pimephales vigilax*
Flathead Chub - *Platygobio gracilis*
Western Blacknose Dace - *Rhinichthys obtusus*
Rudd - *Scardinius erythrophthalmus**
Creek Chub - *Semotilus atromaculatus*

Family Catostomidae

River Carpsucker - *Carpiodes carpio*
Quillback - *Carpiodes cyprinus*
Highfin Carpsucker - *Carpiodes velifer*
White Sucker - *Catostomus commersonii*
Blue Sucker - *Cycleptus elongatus*
Northern Hogsucker - *Hypentelium nigricans*
Smallmouth Buffalo - *Ictiobus bubalus*
Bigmouth Buffalo - *Ictiobus cyprinellus*
Black Buffalo - *Ictiobus niger*
Spotted Sucker - *Minytrema melanops*
River Redhorse - *Moxostoma carinatum*
Black Redhorse - *Moxostoma duquesnii*
Golden Redhorse - *Moxostoma erythrurum*
Shorthead Redhorse - *Moxostoma macrolepidotum*

Order of Catfish (Siluriformes)
Family Ictaluridae

White Catfish - *Ameiurus catus**
Black Bullhead - *Ameiurus melas*
Yellow Bullhead - *Ameiurus natalis*
Brown Bullhead - *Ameiurus nebulosus**
Blue Catfish - *Ictalurus furcatus*
Channel Catfish - *Ictalurus punctatus*
Slender Madtom - *Noturus exilis*
Stonecat - *Noturus flavus*
Tadpole Madtom - *Noturus gyrinus*
Brindled Madtom - *Noturus miurus*

Freckled Madtom - *Noturus nocturnus*
Neosho Madtom - *Noturus placidus*
Flathead Catfish - *Pylodictus olivaris*

Order of Pikes and Mudminnows (Esociformes)
Family Esocidae — Northern Pike - *Esox lucius**

Order of Trouts, Salmons and Smelts (Salmoniformes)
Family Osmeridae — Rainbow Smelt - *Osmerus mordax**

Family Salmonidae — Rainbow Trout - *Oncorhynchus mykiss**
Brown Trout - *Salmo trutta*

Order of Cods (Gadiformes)
Family Gadidae — **Burbot - *Lota lota***

Order of Silversides (Atheriniformes)
Family Atherinopsidae — Brook Silverside - *Labidesthes sicculus*
Inland Silverside - *Minidia beryllina*

Order of Topminnows (Cyprinodontiformes)
Family Fundulidae — Northern Studfish - *Fundulus catenatus*
Northern Plains Killifish - *Fundulus kansae*
Blackstripe Topminnow - *Fundulus notatus*
Blackspotted Topminnow - *Fundulus olivaceus*
Plains Topminnow - *Fundulus sciadicus**

Family Poeciliidae — Western Mosquitofish - *Gambusia affinis**

Order of Mail-cheeked fishes (Scorpaeniformes)
Family Cottidae — Banded Sculpin - *Cottus carolinae*

Order of Spiny-finned fishes (Perciformes)
Family Moronidae — White Perch - *Morone americana**
White Bass - *Morone chrysops*
Yellow Bass - *Morone mississippiensis**
Striped Bass - *Morone saxatilis*

Family Centrarchidae — Rock Bass - *Ambloplites rupestris**
Green Sunfish - *Lepomis cyanellus*
Warmouth - *Lepomis gulosus*
Orangespotted Sunfish - *Lepomis humilis*
Bluegill - *Lepomis macrochirus*
Longear Sunfish - *Lepomis megalotis*
Redear Sunfish - *Lepomis microlophus**
Smallmouth Bass - *Micropterus dolomieu*

	Spotted Bass - *Micropterus punctulatus* Largemouth Bass - *Micropterus salmoides* White Crappie - *Pomoxis annularis* Black Crappie - *Pomoxis nigromaculatus**
Family Percidae	Greenside Darter - *Etheostoma blennioides* Bluntnose Darter - *Etheostoma chlorosoma* Arkansas Darter - *Etheostoma cragini* **Iowa Darter - *Etheostoma exile*** Fantail Darter - *Etheostoma flabellare* Slough Darter - *Etheostoma gracile* Least Darter - *Etheostoma microperca* Johnny Darter - *Etheostoma nigrum* Stippled Darter - *Etheostoma punctulatum* Orangethroat Darter - *Etheostoma spectabile* Speckled Darter - *Etheostoma stigmaeum* Redfin Darter - *Etheostoma whipplii* Banded Darter - *Etheostoma zonale* Yellow Perch - *Perca flavescens** Logperch - *Percina caprodes* Channel Darter - *Percina copelandi* Blackside Darter - *Percina maculata* Slenderhead Darter - *Percina phoxocephala* River Darter - *Percina shumardi* Sauger - *Stizostedion canadense* Walleye - *Sander vitreus**
Family Sciaenidae	Freshwater Drum - *Aplodinotus grunniens*
Family Cichlidae	Tilapia - *Sarotherodon* spp.*

F. FISHES OF KONZA PRAIRIE

Family Catostomidate – Suckers

White Sucker - *Catostomus commersoni*
Shorthead Redhorse - *Moxostoma macrolepidotum*

Family Centrarchidate – temperate basses

Green Sunfish - *Lepomis cyanellus*
Orangespotted Sunfish – *Lepomis humilis*
Bluegill - *Lepomis macrochirus*
Longear Sunfish - *Lepomis megalotis*
Largemouth Bass - *Micropterus salmoides*

Family Cyprinidte – minnows

Stoneroller - *Campostoma anomalum*
Red Shiner - *Cyprinella lutrensis*
Common Shiner - *Luxilus cornutus*
Redfin Shiner – *Lythrurus umbratilis*
Sand Shiner - *Notropis ludibundus*
Southern Redbelly Dace - *Phoxinus erythrogaster*
Bluntnose Minnow - *Pimephales notatus*
Fathead Minnow – *Pimephales promelas*
Creek Chub - *Semotilus atromaculatus*

Family Ictaluridae – catfishes

Black Bullhead - *Ameiurus melas*

Family Percidae – perches

Johnny Darter - *Etheostoma nigrum*
Orangethroat Darter - *Etheostoma spectabile*

Family Poecilidae – livebearers

Western Mosquito Fish – *Gambusia affinis*